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SYSTEM AND METHOD FOR TREATING A FLUID IN A PIPE

Background

[0001] This invention relates to a system and method for treating a fluid flowing in a pipe and, more particularly, to increase the viscosity of the fluid.

[0002] When certain fluids, such as crude oil, are introduced into a pipe at an elevated temperature, the temperature of the fluid will decrease as it flows through the pipe which causes a corresponding increase in the viscosity of the fluid. Also, layers of the fluid as well as various types of materials, such as wax, waxy materials, hydrates, and/or asphaltic components (these materials, as well as other materials that may be present in the fluid, are hereinafter collectively referred to as "materials"), that are present in the fluid may deposit on the inner wall of the pipe.

[0003] The above increases in the viscosity of the fluid, the presence of materials in the fluid, and the build up of the fluid and the materials on the pipe wall, impede the flow of the fluid through the pipe. Therefore, the amount of pressure, and therefore energy, required to pump the fluid through the pipe is increased.

[0004] The present invention is an improved, non-invasive, technique for reducing the viscosity of the fluid as it flows through the pipe and for removing materials from the wall of the pipe.

Brief Description of the Drawings

[0005] The drawing is a sectional view of a pipe depicting an embodiment of the invention.

Detailed Description

[0006] Referring to the drawing, the reference 10 refers, in general, to a pipe which may be part of a pipeline or piping system for the purpose of transporting a fluid, such as crude oil or other hydrocarbons, from a source to a destination. It is understood that materials (defined above) may be contained in the fluid and some of the materials may accumulate on the inner wall of the pipe 10.

[0007] According to an embodiment of the present invention, an electromechanical transducer 12 is placed in the interior of the pipe 10 and affixed to the inner wall of the pipe 10 in any conventional manner. An example of the transducer 12 is disclosed in U.S. patent No. 6,619,394, the disclosure of which is incorporated herein by reference in its entirety.

[0008] The transducer 12 is connected to an electrical energy source 14 which, for the purpose of example, is also shown in the interior of the pipe 10. The electrical energy source 14 can be in the form of a battery pack, or other electrical power source.

[0009] The transducer 12 includes an active element, preferably in the form of a piezoelectric ceramic, that is adapted to vibrate in response to an electrical input to produce oscillatory waves at an ultrasonic frequency. This acoustic energy has two mechanisms, one of which is an acoustic cavitation mechanism that causes an increase of the local temperature of the fluid which decreases the viscosity of the fluid and therefore decreases the amount of materials contained in the fluid. The other mechanism is an acoustic streaming mechanism which disintegrates any materials, and/or layers of the fluid on the wall of the pipe 10. The acoustic cavitation mechanism and the acoustic streaming mechanism are well disclosed in the article entitled "Acoustic streaming and temperature elevation in focused Gaussian beams" written by Hai-Ying Huang, Tomoo Kamakura, and Yoshiro Kumamoto and published in the Journal of Acoustic Society Japan, (E) 18,5 (1997), the disclosure of which is incorporated herein by reference in its entirety.

[0010] In the present case, the strength and frequency of the acoustic energy from the transducer 12 is adjusted depending on the type, flow rate, and temperature of the fluid in the pipe 10, as well as the build up of the fluid and materials on the wall of the pipe 10, so that the acoustic energy (1) reduces the viscosity of the fluid, (2) removes any layers of the fluid on the wall of the pipe 10, (3) removes any materials contained in the fluid, and (4) removes any of the materials accumulating on the wall of the pipe 10.

[0011] In achieving the above, the particles of material contained in the fluid and accumulating on the wall of the pipe 10, are disintegrated into very small particles. The latter particles are either dissolved into the fluid or easily carried by the fluid as it flows in the pipe 10 to the destination.

[0012] It is understood that the pipe 10 may be utilized to transfer fluid from a well to the surface including applications involving a fluid at an elevated temperature that flows upwardly as it cools down. This is especially true for offshore wells in oil recovery operations when the temperature of the oil quickly drops when it moves into a riser. The pipe 10 may also be utilized to transfer fluid containing hydrocarbons between surface facilities. The above embodiment also lends itself to relative long pipelines and/or pipelines in a relatively cold area.

[0013] Several variations of the above may be made within the scope of the invention. For example, although only one transducer 12 is shown and discussed above, it is understood that additional transducers can be placed in the pipe 10 at spaced intervals. Also, the transducer 12 is not limited to the one disclosed in the above patent, but can take other forms. Further, the electrical source 14 can be located externally of the pipe 10 and connected to the transducer 12 by suitable electrical conductors. Still further, the transducer 12 can include an active element, other than a piezoelectric ceramic, that is adapted to vibrate in response to an electrical input to produce the acoustic energy discussed above. Moreover, the present invention is not limited to the fluids discussed above, nor to the removal of any particular materials from any particular fluid, but is equally applicable to other fluids and/or materials.

[0014] The foregoing descriptions of specific embodiments of the present invention have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the invention to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teaching. The embodiments were chosen and described in order to best explain the principles of the invention and its practical application, to thereby enable others skilled in the art to best utilize the invention and various embodiments with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto and their equivalents.

[0015] What is claimed is: